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NATIONAL HYDRAULIC LABORATORY

On May 14 last, the following bill was signed by the President:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be established in the Bureau of Standards of the Department of Commerce a national hydraulic laboratory for the determination of fundamental data useful in hydraulic research and engineering, including laboratory research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories: Provided, That no test, study, or other work on a problem or problems connected with a project the prosecution of which is under the jurisdiction of any department or independent agency of the Government shall be undertaken in the laboratory herein authorized until a written request to do such work is submitted to the Director of the Bureau of Standards by the head of the department or independent agency charged with the execution of such project: And provided further, That any State or political subdivision thereof may obtain a test, study, or other work on a problem connected with a project the prosecution of which is under the jurisdiction of such State or political subdivision thereof.

Sec. 2. There is hereby authorized to be appropriated out of any money in the Treasury not otherwise appropriated, not to exceed $350,000, to be expended by the Secretary of Commerce for the construction and installation upon the present site of the Bureau of Standards in the District of Columbia of a suitable hydraulic laboratory building and such equipment, utilities, and appurtenances thereto as may be necessary.

A number of Government departments have a long list of urgent problems awaiting solution, and the experiments in connection therewith will be taken up in the new laboratory as soon as it is completed. Among these are questions relating to large reclamation and water conservation projects in the West, the control of erosion below spillways and dams, losses of head in large pipe and channel bends, the flow of water over dams, the entrainment of air at tunnel and syphon entrances, the regulation of rivers, the laws of silting and erosion in drainage ditches and streams, and the improvement of instruments and devices for measuring flowing water.

Owing to the great variety of problems which will be submitted for study, the equipment of the new laboratory will be designed to furnish the greatest possible flexibility of arrangement and combination, so that it can be adapted easily to the simultaneous study of a number of different problems.

The fixed equipment will include electrically driven pumps for circulating the water, a large concrete water-supply basin, a concrete measuring tank. several steel weighing tanks, elevated control tanks for supplying water under several different fixed heads, a standpipe and piping systems for distributing this water to all parts of the laboratory and for returning it from the models under test to the supply basin. A large unobstructed floor will be provided where a number of models can be built and tested simultaneously.

ARCHITECTURAL ACOUSTICS

The following is a summary of a paper presented by Dr. Paul R. Heyl, chief of the sound section of the bureau, before the Maryland Academy of Sciences at Baltimore, on May 21.

There are but two problems in the science of architectural acoustics, both of a very practical character. We may designate them as the private and the public problem.

The private problem is that of producing soundproof partitions. The increasing concentration of city dwellers in office buildings and apartment houses has intensified the demand for reasonably soundproof partition walls and floors. This problem has been studied at the Bureau of Standards for the past six or seven years, and several hundred types of partitions have been studied ranging from an 8-inch concrete wall to a single sheet of wrapping paper. As a result of these measurements certain fundamental principles have been established.

In the first place, when we are dealing with homogeneous walls it has been found that the sound transmission is determined by the weight of the wall per square foot. This means that a thin sheet of steel and a thick sheet of fiber board, both of the same weight per square foot, will transmit sound equally well. In other words, as far as homogeneous walls are concerned, there is no "best sound insulating material."

But to obtain satisfactory sound insulation in this way would involve walls of prohibitive weight and cost. Good results can be obtained at less expense by means of walls built up of different layers of material.

Here we must distinguish between heavy and light walls. For walls of masonry or of lath and plaster construction, it has been found that the best results are obtained by the use of an empty air space in the wall. For such walls filling materials in this air space are of doubtful value, sometimes actually increasing the sound transmission. For example, two 4-inch brick walls separated by a 4-inch air space are better than an 8-inch brick wall.

For light partitions, such as are used between offices, a filling material may be advantageous. Such partitions may consist of two sheets of metal with a fibrous filling between them. Excellent results have been obtained in this way in the structure of airplane cabins. It has been found possible, by means of a partition weighing only 1¼ pounds per square foot, to reduce the noise inside the cabin to about the same level as that in a railway coach in motion, while in the open cockpit of a plane in flight it is impossible to hear a shout.

We have been speaking hitherto of air-borne noises. We must also deal with impact noises, such as those caused by walking, moving furniture, or dropping objects. These noises are much more difficult to insulate than those of the air-borne type. The best way that has been found to deal with such sounds is a combination of a floating floor and a suspended ceiling, each with an air space between it and the main partition.

The public problem is that of good acoustics in an auditorium. In the first place, curved walls and domes should be avoided, as they give rise to sound foci and dead spots. Rectangular outlines are best for good hearing.

In the second place, excessive reverberation is to be avoided. This is the most common defect of auditoriums, and arises from deficient sound absorption in the interior finish. The sound of a syllable or a note of music is prolonged so as to interfere with the following syllable or note.

Acoustic correctives are on the market in the form of special plasters, for use in new buildings, and various fibrous materials for use in old buildings, when it is not desired to replaster. The necessary calculations for the amount of absorption needed are explained in Bureau of Standards Circular No. 380, entitled "Architectural Acoustics," to be had from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price of 5 cents.

SOUND ABSORPTION COEFFICIENTS

The first table below gives figures which have recently been obtained at the bureau for the sound-absorption coefficients of a number of materials now on the market as acoustic correctives. The second table gives figures for the absorption of an audience seated in chairs of different kinds. The results have all been obtained by the reverberation method.

It is not necessarily the case that the materials of highest coefficient are the most advantageous. When there is room enough to apply the requisite quantity, a material of low coefficient will give the same result.

TABLE 1

Material	Absorption coefficients for frequencies—				
	128	256	512	1,024	2,048
Acoustex, 1 inch thick, spray painted	0.12	0.24	0.35	0.56	0.77
Acoustex, 2 inches thick	.22	.41	.64	.86	.84
Acoustolith tile, type D:					
1 inch thick	.08	.13	.25	.54	.67
2 inches thick	.15	.26	.59	.74	.52
Balsam wool, 1 inch thick, scrim facing	.18	.36	.55	.65	.67
Celotex:					
Type B	.16	.26	.40	.62	.64
Type BB	.19	.42	.61	.72	.76
Type BB painted	.19	.34	.62	.75	.77
Flaxlinum, 1 inch thick	.09	.31	.62	.77	.69
Hachmeister-Lind acoustic plaster:					
Stippled with pins ½ inch deep	.16	.19	.25	.36	.44
Float finish	.17	.14	.14	.16	.15
Nashkote A:					
½ inch thick	.05	.13	.25	.26	.20
¾ inch thick	.09	.16	.27	.30	.23
1 inch thick	.12	.20	.33	.33	.28
Nashkote B-332:					
½ inch thick	.09	.15	.31	.52	.74
¾ inch thick	.12	.21	.40	.63	.81
1 inch thick	.19	.26	.50	.73	.89
Macoustic plaster:					
Stippled ½ inch thick	.09	.14	.22	.27	.41
½ inch thick, stippled with large pins, perforations ½ inch deep	.12	.20	.31	.39	.58
Sabinite, ½ inch thick	.15	.17	.22	.29	.38
Sanacoustic tile, rock wool filler, 1¼ inches thick	.17	.41	.82	.94	.85
Soundex:					
1 3/16 inches thick, spray painted	.10	.22	.36	.53	.72
1 3/16 inches thick, spray painted	.21	.26	.48	.68	.75
U. S. Gypsum Tile:					
½ inch thick	.07	.17	.44	.62	.60
¾ inch thick	.16	.28	.52	.66	.58
1 inch thick	.18	.37	.59	.64	.61

TABLE 2

Kind of audience	Absorption per person at frequencies—				
	128	256	512	1,024	2,048
Women without coats [1]	0.7	1.3	2.3	3.6	4.6
Women with coats [1]	1.3	2.4	4.0	5.8	6.7
Men without overcoast [1]	1.3	2.1	4.1	5.5	7.4
Men with overcoats [1]	2.3	3.2	4.8	6.2	7.6
Mixed audience [2]	-----	-----	3.9	4.7	-----
Empty seat [2]	-----	3.4	3.0	3.3	3.6
Mixed audience [3]	-----	3.5	4.1	4.9	4.2
Empty seat [3]	-----	3.0	2.5	2.9	3.1
Mixed audience [4]	-----	2.7	3.3	3.8	3.6

[1] Cane-seat chairs, open back.
[2] Theater chair, box-spring seat, heavily padded back.
[3] Same as 2, but single layer of padding on back.
[4] Church pews, seating 5.

THERMAL EXPANSIONS OF FUSED ALUMINA, BAUXITE, AND DIASPORE

Among the refractory materials included in an investigation of the linear thermal expansion of special refractories from atmospheric temperature to 1,800° C. are samples of fused alumina (artificial corundum), bauxite containing approximately 80 per cent alumina (water-free basis), and diaspore of the grade used in the manufacture of refractories.

The data obtained are as follows:

A. Corundum. Specimens commercially prepared.

1. Tested as received.

1a. Maximum expansion, 1.13 per cent obtained at 1,480° C.

1b. Rate of expansion uniform, increasing very slowly to approximately 1,000° C. and decreasing gradually up to 1,480° C. Specimen contracted rapidly from 1,480° to 1,800° C.

1c. Petrographic examination shows material to be composed almost entirely of corundum.

2. Tested after heating twice to 1,800° C.

2a. Maximum expansion, 1.49 per cent, obtained 1,750° C.

2b. Coefficient of expansion from 20° to 1,750° C. is 8.6×10^{-6}.

2c. Rate of expansion fairly uniform up to 1,360° C.; from 1,360° to 1,585° C., it decreases decidedly, and increases from 1,585° to 1,750° C.

2d. Material shows no deformation after completion of tests.

2e. Petrographic examination shows corundum crystals to be slightly larger than before heat treatment. A rim of mullite is around some of the crystals.

B. Bauxite.

1. Specimen fired at 1,400° C. for 5 hours.

1a. Maximum expansion, 0.72 per cent at 1,100° C.

1b. Expansion uniform from 20° to 1,100° C. with specimen contracting rapidly after passing 1,100° C.

1c. Petrographic examination shows material to consist principally of corundum, mullite, and glass. Probably about 70 per cent corundum present.

2. Specimen heated to 1,675° C.

2a. Maximum expansion, 1.38 per cent, obtained at 1,300° C.

2b. Impurities present caused rapid contraction of the material beginning at 1,400° C.

2c. Average coefficient of linear thermal expansion from 20° to 1,300° C. is 8.1×10^{-6}.

2d. Specimen showed decided deformation after heating.

2e. Petrographic examination shows less corundum present and the mullite crystals to be much larger than in specimen heated to 1.400° C.

C. Diaspore.

1. Heated to approximately 1,575° C.

1a. Maximum expansion, 0.99 per cent obtained at 1,280° C.

1b. Specimen contracted rapidly after reaching 1,360° C.

1c. Petrographic examination indicates the material to be composed almost entirely of corundum and glass.

2. Specimen heated to 1,730° C.

2a. Maximum expansion, 1.18 per cent, obtained at 1,580° C.

2b. Average coefficient of linear thermal expansion from 20° to 1,580° C. is 7.6×10^{-6}.

2c. The specimen showed slight deformation after completing test.

2d. Petrographic examination indicates the corundum grains to have increased in size. A small amount of mullite is also present.

COMPOSITE BEAMS AND SLABS OF HOLLOW TILE AND CONCRETE

In cooperation with the Hollow Building Tile Association (now the Structural Clay Tile Association, 1400 Engineering Building, Chicago, Ill.), tests have been made to determine the strength of composite beams and slabs of hollow tile and reinforced concrete. The tests were planned to obtain information on the value of the tiles in assisting the concrete to resist shearing and bending failures.

Sixty beams or slabs were fabricated and tested in the bureau's laboratories. Forty-eight of those were composite beams consisting of either one or two reinforced concrete ribs similar to those in ribbed floors of concrete and hollow tile. The remaining 12 were concrete beams, each being similar in design and materials to the concrete portions of some of the composite beams. Some of each type were heavily reinforced for bending stresses and were tested in a manner to produce shearing failures; others were designed and tested to develop high compressive stresses in the concrete. All beams were 8 inches in depth; those for the shear tests were 6 feet 4 inches in length and from 4 to 29 inches in width, while those for the bend tests were 15 feet in length and either 8 or 29 inches in width.

The hollow tiles used in the construction of the beams for the shear tests were selected to provide data for the determination of the effect on the shearing strength of the physical properties of the tiles, their weight and number of vertical interior webs. The bend tests were planned to give information on the effects of the weight, number of cells, and arrangement of the tiles on the strength of the beams in bending.

In the construction of the beams no attempt was made to obtain specimens representative of commercial construction. On the contrary, the aim was to obtain specimens of uniform quality as regards the characteristics of the concrete and workmanship in order to minimize variations in the results from uncontrolled causes.

All beams were kept damp for 28 days after construction, and were then permitted to dry in the laboratory for approximately two weeks before testing. The average strengths of 6 by 12 inch cylinders representing the concrete of the beams were 2,720 lbs./in.^{2} at the age of 28 days and 3,070 lbs./in.^{2} at 42 days.

The results of the tests indicated that one row of tiles was equivalent in resisting shear to a concrete rib of the same depth and having a width of from 1.6 to 2.4 inches. These equivalent widths were greatest for the tiles made of the material of the highest strength and modulus of elasticity. However,

the tiles made of the weaker materials usually had thicker shells which compensated in part for their weaker structure. At loads considerably less than the maxima the tiles were more effective in increasing the resistance of the beams to bending deformations than at the higher loads. The relatively lower values for the higher loads are believed to be due at least in part to partial failure of the bond between the concrete and tiles. The results of subsequent tests indicated that the method followed in the construction and aging of the beams was not favorable to the development of as strong a bond as would have been obtained with other methods.

A full report of the investigation was published in the Bureau of Standards Journal of Research (Vol. 4, No. 6, p. 815 (RP181); June, 1930).

SEPARATION OF COLLOIDAL MATERIAL FROM CERTAIN OHIO SHALES

The separation of the colloidal material from certain Ohio shales has been completed at the Columbus branch of the bureau. The method used consisted of blunging, sedimentation, supercentrifuging at speeds of 12,000 and 20,000 r. p. m., and filtering through Pasteur tubes.

The material separated at 12,000 r. p. m. centrifuge speed varies from 0.2 per cent for the Chagrin shale to 11.4 per cent for the Bedford; the material separated at 20,000 r. p. m. centrifuge speed varies from 0 per cent for the Chagrin shale to 2.6 per cent for the Bedford, and the sum of the material separated on the filter varies from 0.05 per cent for the Chagrin shale to 1.95 per cent for the Bedford. The quantities obtained for the other eight shales were intermediate between these two.

In a general way the physical properties, slaking time, tempering water, drying shrinkage, and green modulus of rupture all show increases, with an increase in the quantity of colloidal matter separable by the above method. The slaking time and tempering water correlate fairly well with colloid content. The Bedford shale shows an unusually high slaking time and an unusually low requirement of tempering water as compared with the others. The correlation between drying shrinkage and modulus of rupture and colloids mechanically separable by the above method is much poorer, however, though in both shrinkage and modulus the increase in their values with increase in separable colloid present is fairly well defined as a general trend from which individual deviations are to be expected.

Work is being continued with the alluvial and glacial clays.

RELATION OF SIZING MATERIALS TO STABILITY OF PAPER

Additional results have been obtained in the study of glue and starch-sized papers prepared recently in the bureau's experimental paper mill from highly purified wood fibers. The papers were tub sized with these materials; that is, sized by passing them through solutions of them. The sized papers were tested for alpha cellulose content and copper number, and the effect of heating on these properties determined.

Four different tub-size runs—glue, glue and alum, starch, and starch and alum—were made on each of three different base papers. These basic papers were a waterleaf, and two engine-sized papers sized, respectively, with one-half and 1 per cent rosin. Controls of the unsized papers corresponding to each of the tub-size runs were tested individually, including the stability test. These control samples were taken just before and after each run so as to be representative of that particular run. This plan of testing provided four individual fold and tear retention values on each of the three basic papers, and made possible some conclusion as to the reproducibility to be expected in these stability tests. A summary of these values is tabulated below.

Basic paper	Retention of fold		Retention of tear	
	Average	Average variation from the average	Average	Average variation from the average
	Per cent	*Per cent*	*Per cent*	*Per cent*
Waterleaf	99	9	91	2.0
Engine-sized:				
1/2 per cent rosin	87	6	90	1.5
1 per cent rosin	84	7	88	2.0

While there are comparatively wide variations in individual fold-retention figures, the variations are no greater than commonly experienced in folding tests.

All the papers were found to be very stable toward the heat test, exhibiting very little change in strength. In all cases upwards of 80 per cent of the

initial folding endurance was retained after heating. Papers tub sized with glue or starch containing alum were found to be no less stable than corresponding papers containing no alum in the size baths.

The stability as determined by decrease in alpha cellulose and increase in copper number on heating is improved somewhat on tub sizing, evidently through the protective effect of the surface coating of glue. The presence of alum in the tub-sizing bath has no deleterious effect upon the stability as measured by changes in alpha cellulose and copper number. This agrees with previous conclusions as to the relative harmlessness of external acidity; that is, acidity added by the tub sizing. The excellent stability of all these papers is further indicated by the fact that in all cases the decrease in alpha cellulose on heating is less than 1 per cent, and the increase in copper numbers less than 0.2. These results further confirm those obtained by the bureau in tests of commercial papers.

DETERIORATION OF LEATHER

Further evidence that leather will deteriorate as a result of taking up sulphur from the surrounding air has been secured by examining samples of pigskin leather taken from doors in the New York Public Library. Three samples, all in use for 20 years, were examined. No. 1 represented material which had been covered with metal face plates and consequently had been subjected to the least exposure to atmospheric and service conditions. Sample No. 2 was taken from doors which had been stored in the dark basement ever since the delivery of the material. Sample No. 3 was taken from doors in use in the corridors of the building.

An inspection of these samples showed that Nos. 2 and 3 tore very easily, possessed very little strength, and were in a condition representing practically complete deterioration. Sample No. 1, which had some protection from service conditions, was lighter in color and possessed considerable strength. The results of physical and chemical tests made on the samples are listed below.

Sample No.	Grease	Acid as H_2SO_4	Ash	Iron as Fe_2O_3	Tensile strength	Probably tanned with
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs./in.²*	
1	3.74	2.04	1.02	0.09	2,105	Sumac.
2	3.21	4.55	1.35	.16	480	Do.
3	2.72	4.60	1.59	.12	440	Do.

Although the chemical constituents and strength are not known for this leather when it was new, it is considered fair to assume that the acid content did not exceed 0.50 per cent, that the ash content did not exceed 0.50 per cent, and that the tensile strength was around 3,500 lbs./in.^{2} On this basis, the test results show that there was a material increase in the acid and ash contents of these leathers during service, which was accompanied by a marked decrease in the strength of the leathers. Sample No. 1, which had a measure of protection from service conditions, is estimated to have dropped about 40 per cent in strength. Samples Nos. 2 and 3 are estimated to have dropped about 87 per cent in strength, there being little difference between the leather in actual service and that stored in the library basement.

It appears significant that the sulphuric acid determinations show the latter samples, which were about completely destroyed, to have gained enough sulphur in service to account for a probable increase of 4 per cent in sulphuric acid. Sample No. 1, which had a measure of protection from light and air, showed a probable increase of 1.5 per cent sulphuric acid, and also showed much less deterioration as measured by the drop in strength. It is believed that the sulphuric acid caused the deterioration of these leathers. Research work in the bureau's laboratory has shown that leather, to which from 4 to 4.5 per cent of sulphuric acid has been added, has decreased in strength from 60 to 75 per cent during storage for a 2-year period under comparatively ideal conditions. It is believed that leather, which over a period of years takes up a like amount of sulphuric acid from a polluted atmosphere, will inevitably show a similar deterioration.

PLATINUM PLATING FOR REPAIRED WEIGHTS

For many years platinum plating was generally considered of doubtful value for weights. The character of the plating done by different firms differed widely, the platinum coating was likely to be very porous, and the weights tended to gain excessive amounts.

Within the past few years there appears to have been considerable improvement in the general character of platinum plating. In particular, sets of 1-piece weights have shown very satisfactory behavior on boiling in distilled water, and on short-time tests of constancy under good atmospheric conditions.

These improvements induced the bureau about two years ago to try platinum plating on some old sets of ordinary analytical weights that were in need of repair. These weights were of the usual screw-knob type, and some trouble was experienced because of failure to thoroughly wash out the cavity under the knob. Such trouble, however, may be experienced from any kind of electroplating on weights of this type.

Thirteen sets of these weights, repaired at various times, have been retested during the past three months. All but three sets had been in use under fairly good conditions, since the weighing rooms where they were used are separate from the laboratories. The three unused sets have been kept in the stock room for about six months.

The unused sets showed no significant changes, the maximum apparent change being 0.03 mg. There is some doubt as to whether many sets are likely to show this degree of constancy even under these conditions.

Weights of the sets which had been regularly in use showed a marked tendency to gain. There were no significant losses even in sets which had been used to such an extent that losses normally would be expected through wear. About 30 per cent of the weights gained nearly or over 0.1 mg. The two largest changes were those of two 100 g weights, one of which gained 0.4 mg and the other 0.8 mg.

These results do not prove that platinum plating causes a greater tendency to change than would be caused by plating with other metals, but they do show conclusively that platinum plating can not be relied on to produce constant weights. Any plated weights, no matter what plating is used, must be carefully checked for constancy.

Porosity of the brass, resulting in surface spotting of many of these weights, may account for some of the tendency to change. Therefore, there is danger in electroplating old weights, especially old lacquered weights, because they may be made of porous metal. Moreover, some of the weights tarnished without any definite evidence of porosity while some weights gained serious amounts without any evident tarnishing or spotting. Among the latter was one set that had been plated at the bureau.

In repairing old sets, the advantages of platinum plating may sometimes outweigh the danger of inconstancy, especially where the weights can be recalibrated often enough to insure the accuracy of the values used. The experience with these weights shows, however, that danger of some inconstancy must be included in the consideration of advantages and disadvantages.

NEW CONSISTOMETER FOR MEASURING PROPERTIES OF GREASES AND OILS AT LOW TEMPERATURES

The July number of the Bureau of Standards Journal of Research will contain a description of a simple and rugged consistometer which is speedy in operation and which can be employed for either opaque or clear materials of a wide range of consistencies. It also possesses two features which are unusual in a consistometer, but which are of great importance in the testing of all such plastic materials as show a breakdown of structure with working, or which change in consistency with time.

The first of these features is that the test material may be passed successively back and forth through the capillary any number of times. The second is that determinations of the rate of flow are made by passing only a very small volume of material through the capillary, thus minimizing the breakdown effect of the working which is incident to the measurement itself.

With the aid of these two features the unworked, as well as the thoroughly worked, consistency of the material may be closely approximated. With such forms of instrument as permit flow in one direction only, and for which a large amount of material must be passed through the capillary for a single datum point, neither the unworked nor the worked consistency is obtained, but only an intermediate consistency on partially worked and constantly changing material. The first of the two special features also makes it possible to obtain flow-pressure graphs at a number of temperatures, with a single filling of the instrument, or without removing the instrument from the bath. There are no weighings to be performed and no auxiliary apparatus is required, such as pressure tanks, pressure regulators, etc. The instrument can also be used to measure accurately the viscosity of simple viscous liquids up to many thousands of poises. Most viscometers are suitable only for materials of less than about 100 poises.

Many plastic materials, such as jellies, clay slips, greases, pastes, etc., show a more or less pronounced breakdown of structure and consequent loss of "body" when they are worked mechanically. For such materials the unworked consistency of the undisturbed substance, and the thoroughly worked consistency of the completely broken-down material are, in general, of vastly greater importance than the variable consistency

which the material possesses in any intermediate condition. For example, when starting an automobile engine in cold weather, the amount of resistance to flow which the oil offers before its plastic structure is broken down is an important consideration in the proper lubrication of the working parts of the machine. After the machine has been running a few minutes the plastic structure of the oil is destroyed, and the consistency of the worked or broken-down product is the important feature. The consistency of the oil in between times is of slight importance, yet it is this consistency which is measured when a freshly cooled oil is subjected to a single passage through a capillary, as is frequently the case in determining consistency by many old-style instruments.

The present paper gives flow-pressure graphs illustrating how the new instrument may be employed to approximate closely the unworked consistency and to measure accurately the thoroughly worked consistency of plastic oils at 0° C. Such oils at this temperature were found to behave like jellies and gelatins in that they continued to increase in stiffness for many hours after all the oil had acquired the temperature of test. Certain oils also were found to possess marked thixotropic characteristics; that is to say, they partially regained their former structure and high resistance to flow when they were merely allowed to stand undisturbed for a period after a thorough mechanical working.

EFFECT OF VARYING DEVELOPMENT UPON RESOLVING POWER AND SENSITIVITY OF PHOTOGRAPHIC PLATES

Special developers recommended for reducing the graininess of photographic images are all based on increasing the solvent action of the solution on silver bromide, and decreasing the reduction potential, thus tending to make their action more like the physical developers in which the silver of the image is supplied by the solution. A number of these developers have been compared with ordinary metolhydroquinone and pyrogallol formulas for usefulness in spectrography and other applications involving fine details of the image. Three emulsions were tested for sensitivity and resolving power when developed with each of the developers, and practical spectrographic tests were made with one of the plates. As determined by a parallel-line test object, only developers of very low reduction potential and low rate of development improved resolution to any appreciable extent, and these have no practical value because they reduce the speed of the emulsions. The "borax" developers recommended for motion-picture films are at least equal to the standard formulas on the basis of sensitivity and resolution. The tests here applied appear to have little or no bearing on the pictorial use of special developers to reduce "graininess."

This work will be discussed at greater length in the July number of the Bureau of Standards Journal of Research.

PERFORMANCE CHARACTERISTICS OF 2-BLADE PROPELLER FANS

Some time ago an investigation was undertaken of the performance of 2-blade propeller fans, to obtain data needed by the industry. Recently there has been a trend toward the use of fans of this type in cooling-tower installations, and their use has been considered for other applications where it is desired to move large volumes of air against relatively low pressures. Since no data were available as to the operating characteristics of 2-blade propeller fans, the importance to the manufacturer and user of obtaining this information is obvious.

Seven 2-blade propeller fans, 8 feet in diameter and of pitch diameter ratios 0.250, 0.375, 0.500, 0.625, 0.938, and 1.063, respectively, were tested under operating conditions approximating those encountered in cooling towers. Each fan was operated at constant speed of rotation against resistance conditions which were varied by steps, from a completely blocked passage to as nearly an open passage as the conditions in the test duct permitted. The volume of air moved in unit time, the head developed, and the power absorbed by the fan were determined for each resistance condition. Data were obtained for two conditions of operation—(1) with the fan operating as a blower, and (2) with the fan exhausting air from the test duct.

The results were expressed in the form of coefficients and plotted to facilitate their use in estimating the performance of fans of other diameters and of other rotational speeds.

The chief effect of variation of pitch-diameter ratio is to increase the range of the head and volume coefficients with increase in pitch-diameter ratio, up to pitch-diameter ratio of 0.938. Pitch-diameter ratios greater than 1.0 should not in general be used.

Two-blade propeller fans are suitable for moving large volumes of air against pressures that do not exceed 1.0 inch of water. For pressures greater than 1.0 inch of water the rotational speeds become inconveniently large. The speed of rotation and the fan diameter should

be carefully chosen to obtain maximum efficiency.

This work will be fully reported upon in the July number of the Bureau of Standards Journal of Research.

AIRCRAFT RADIO RESEARCH

Experiments are in progress at the bureau on improvements in methods of adjusting the directions of the courses produced by range beacon transmitters to fit airways intersecting at any angles. The aim is to change from the simple 90° or 180° adjustments to other angles without material loss of distance range. Apparently this can be accomplished by the use of a short vertical antenna on the central supporting mast of the loop antennas. In order to avoid loss of sharpness of course indication, careful attention has to be given to the coupling arrangement to this antenna, its position on the mast, the phases of currents in it and in the loop antennas, and the presence and location of metal parts or electric-light wires on the mast.

Further development of the radio system for blind landing has been in progress for the past two months. Various combinations of the three elements making up the blind-landing system have been tried at College Park, Md. A runway localizing beacon and a high-frequency landing beam transmitter have been placed at one end of the flying field with the localizing beacon course and the landing beam directed along the major runway of the field. A marker beacon is installed at the other end of the field. The angle and transmitted power of the high-frequency landing beam has been adjusted so that an airplane may be guided along the proper gliding path to the field and may land at the proper point on the runway. Experimental work is now being directed to the runway localizing beacon and the marker beacon.

The use of the runway localizing beacon has previously proved difficult because of the necessity for adjusting the receiving set volume control as the airplane is approaching the beacon transmitter. Experiments facilitating the use of the runway localizing beacon through the development of a suitable device for automatically controlling the intensity of the receiving set output signals are in progress. A device of this type would permit the pilot to use the localizing beacon all the way to the point of landing instead of having to abandon it when within one-half to 1 mile of the point of landing (the volume adjustment then becoming too critical) and having to maintain the course (along which the localizing beacon has oriented him) by other means.

The experimental work on the marker beacon is to determine whether an aural or visual type best meets the requirements. Present results indicate that the aural type of marker beacon is preferable, for this particular purpose, since this relieves the pilot of watching an additional instrument.

RADIO SIGNAL TRANSMISSIONS OF STANDARD FREQUENCY, JULY TO DECEMBER, 1930

The bureau announces a new schedule of radio signals of standard frequencies, for use by the public in calibrating frequency standards and transmitting and receiving apparatus. The signals are transmitted from the bureau's station WWV, Washington, D. C. They can be heard and utilized by stations equipped for continuous-wave reception at distances up to about 1,000 miles from Washington.

The transmissions are by continuous-wave radiotelegraphy. A complete frequency transmission includes a "general call," "standard frequency signal," and "announcements." The general call is given at the beginning of each 12-minute period and continues for about two minutes. This includes a statement of the frequency. The standard frequency signal is a series of very long dashes with the call letter (WWV) intervening; this signal continues for about four minutes. The announcements follow, and contain a statement of the frequency being transmitted and of the next frequency to be transmitted. There is then a 4-minute interval while the transmitting set is adjusted for the next frequency.

Information on how to receive and utilize the signals is given in Letter Circular No. 280, which may be obtained by applying to the Bureau of Standards, Washington, D. C. Even though only a few frequencies are received (or even only a single one), persons can obtain as complete a frequency-meter calibration as desired by the method of generator harmonics, information on which is given in the letter circular. The schedule of standard frequency signals is as follows:

Eastern standard time	Frequency in kilocycles					
	July 21	Aug. 20	Sept. 22	Oct. 20	Nov. 20	Dec. 22
10 p. m.	1,600	4,000	550	1,600	4,000	550
10.12 p. m.	1,800	4,400	600	1,800	4,400	600
10.24 p. m.	2,000	4,800	700	2,000	4,800	700
10.36 p. m.	2,400	5,200	800	2,400	5,200	800
10.48 p. m.	2,800	5,800	1,000	2,800	5,800	1,000
11 p. m.	3,200	6,400	1,200	3,200	6,400	1,200
11.12 p. m.	3,600	7,000	1,400	3,600	7,000	1,400
11.24 p. m.	4,000	7,600	1,500	4,000	7,600	1,500

MEETINGS OF METALLURGICAL ADVISORY COMMITTEES

One of the important events at the bureau each year is the meeting of the metallurgical advisory committees. The meetings this year, May 6 and 7, were among the most successful that have so far been held.

Although there are two committees dealing with the ferrous and nonferrous aspects of metallurgy, respectively, no sharp distinction is made in the meetings, which are essentially those of a single metallurgical advisory committee. The nonferrous metallurgical committee has been in existence since 1912 and the ferrous branch was organized a few years later. In the membership are included 36 prominent representative metallurgists of the country and at this year's meeting an attendance of 85 per cent was recorded. In addition, other metallurgists, specialists whose advice on the various metallurgical projects under way is desired, are invited to these meetings, together with such former members of the bureau's metallurgical staff as are still in close contact with the work in progress. Members of other Government bureaus are also invited. A total of 150 attended the meetings this year.

For several years past, it has been customary for the Washington Chapter of the Society for Steel Treating to hold its meeting on the evening of the first day of the committee meeting. At this year's evening meeting the subject of the industrial uses of nickel was discussed.

The character and scope of the program of the meetings is determined by their purpose which is the securing of advice and suggestions on the various metallurgical projects both current and projected. An informal presentation of the present status of a project, giving the accomplishments up to date and the goal in view serves as a nucleus around which the discussion may center. The principal subjects of discussion are given below:

Tuesday, May 6 (a. m.), Dr. G. B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, presiding.

1. Molten metals:
   - (a) "Liquid shrinkage" of metals. (In cooperation with American Foundrymen's Association.)
   - (b) Fluidity of molten metals. (In cooperation with American Foundrymen's Association.)
   - (c) Deoxidation and the problem of "low ductility" in steel castings. (In cooperation with Steel Castings Development Bureau.)
   - (d) Nonferrous ingot metals (new cooperative project, Ingot Metals Association, American Foundrymen's Association, and American Society for Testing Materials).
   - (e) Carbon-oxygen equilibrium in molten iron and the general problem of "gases in steel."
   - (f) Molding sands and cores.

Tuesday (p. m.), Dr. G. B. Waterhouse, presiding.

1. Wrought-steel products:
   - (a) Rails (properties having a bearing on "transverse fissures").
   - (b) Wire (bridge-cable construction).
   - (c) Airplane tubing (methods for sorting mixed-up steels of different composition—the "spark" test).
2. Endurance properties of metals (as related to rail steel and wire in particular).
3. High-temperature properties of steels, i. e., "creep" or "flow" under sustained loading.
4. Quenching of steel—study of different coolants.

Wednesday, May 7 (a. m.), W. H. Bassett, technical superintendent, American Brass Co., and president, American Institute Mining and Metallurgical Engineers, presiding.

1. Wear of metals and related problems:
   - (a) Bearing bronzes. (In cooperation with Bunting Brass & Bronze Co.)
   - (b) "White metal" bearing alloys. (In cooperation with War Department, National Lead Co., Bunting Brass & Bronze Co., and American Society for Testing Materials.)
   - (c) General methods for the study of wear resistance of metals.
   - (d) Cutting of metals (machinability as related to the tool material, and as related to the material to be cut).

Wednesday, May 7 (p. m.), W. H. Bassett, presiding.

1. Corrosion resistance of metals.
   - (a) Aeration factor in submerged corrosion.
   - (b) Corrosion of light alloys.
   - (c) Atmospheric exposure tests. (In cooperation with American Society for Testing Materials.)
     - (1) Screen wire cloth.
     - (2) Nonferrous alloy sheets.

2. Bismuth and its utilization. (In cooperation with Cerro de Pasco Copper Corporation.)
3. Miscellaneous:
   (a) B-ray spectrum of pure iron (A_2 change). In cooperation with alloys-of-iron research.
   (b) Heat conductivity of metals.

CONSTRUCTION ACTIVITY DURING MARCH, 1930

Construction contracts valued at $456,119,000 were awarded in 37 eastern States during March, 1930, according to the F. W. Dodge Corporation. This total was approximately 6 per cent lower than that for March, 1929, but represents an increase of about 44 per cent over February, 1930. With the exception of residential, educational, and social and recreational buildings, which showed decreases of 48, 6, and 16 per cent, respectively, all other classes of construction increased as compared with March, 1929. Among those classes having increases in March, 1930, were public works and public utilities, and hospitals and institutions with gains of 47 and 140 per cent, respectively.

The value of construction contracts awarded during the first quarter of 1930 amounted to $1,097,147,200 as compared with $1,255,829,300, a decrease of about 13 per cent. During this period, residential construction, the largest single class, decreased approximately 48 per cent, while public works and public utilities, another large class, increased 55 per cent. Commercial, industrial, educational, and social and recreational buildings decreased, while increases are noted for hospitals and institutions, religious and memorial, and public buildings.

NEW AND REVISED PUBLICATIONS ISSUED DURING MAY, 1930

Journal of Research [1]

Bureau of Standards Journal of Research, Vol. 4, No. 6, June, 1930 (RP Nos. 176 to 182, inclusive). Obtainable by subscription. See footnote.

Research Papers [1]

(Reprints from Journal of Research)

RP152. Preliminary investigations upon two cellulosic wastes as sources for xylose; W. L. Hall, C. S. Slater, and S. F. Acree. Price, 5 cents.

RP153. Design of a portable temperature-controlled piezo oscillator; V. E. Heaton and W. H. Brattain. Price, 5 cents.

RP157. Transverse tests of H-section column splices; J. H. Edwards, H. L. Whittemore, and A. H. Stang. Price, 10 cents.

RP159. Development of the visual type airway radiobeacon system; J. H. Dellinger, H. Diamond, and F. W. Dunmore. Price, 20 cents.

RP160. A tuned-reed course indicator for the 4 and 12 course aircraft radio range; F. W. Dunmore. Price, 15 cents.

RP161. Physical properties of electrically welded steel tubing; H. L. Whittemore, J. S. Adelson, and E. O. Seaquist. Price, 20 cents.

RP162. Evolution of hydrogen sulphide from vulcanized rubber; E. Wolesensky. Price, 5 cents.

RP163. Reduction of data on mixture of color stimuli; D. B. Judd. Price, 10 cents.

RP164. Tensile properties of rail and some other steels at elevated temperatures; J. R. Freeman, jr., and G. W. Quick. Price, 20 cents.

RP165. A convenient form of Geiger tube counter; L. F. Curtiss. Price, 5 cents.

RP166. Probability fluctuations in the rate of emission of alpha particles; L. F. Curtiss. Price, 5 cents.

RP167. The sensitive surface of the Geiger tube electron counter; L. F. Curtiss. Price, 5 cents.

RP173. Spectral sensitization of photographic emulsions. Notes on bathing with pinacyanol-pinaflavol mixtures; B. H. Carroll and D. Hubbard. Price, 5 cents.

Circulars [1]

C382. Bismuth. (Contains information on history, occurrence and distribution, recovery, properties, uses, binary alloy systems, bibliography, etc.) Price, 10 cents.

Simplified Practice Recommendations [1]

SPR93–29. Paper shipping tags. Price, 10 cents.

SPR105–29. Wheelbarrows. Price, 10 cents.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75; other countries, $3.50. Subscription to Commercial Standards Monthly, $1; other countries, $1.25.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75; other countries, $3.50. Subscription to Commercial Standards Monthly, $1; other countries, $1.25.

SPR110–29. Soft fiber (jute) twine. Price, 10 cents.

Commercial Standards [1]

CS18–29. Hickory golf shafts. Price, 10 cents.

CS19–30. Foundry patterns of wood. Price, 10 cents.

Miscellaneous Publications [1]

M108. Manufacture and properties of a cellulose product (maizolith) from cornstalks and corncobs; C. E. Hartford. Price, 5 cents.

Commercial Standards Monthly [1]

Commercial Standards Monthly, Vol. 6, No. 11, May, 1930. Obtainable by subscription. See footnote.

Technical News Bulletin [1]

TNB158. Technical News Bulletin, June, 1930. Obtainable by subscription. See footnote.

OUTSIDE PUBLICATIONS [2]

In this list are included, in so far as possible, all articles by members of the bureau's staff on scientific and technical subjects. Some of these articles are written in the author's unofficial capacity only and deal with subjects outside the field of the National Bureau of Standards. The article itself should always be consulted to determine whether or not it expresses the official opinion of the bureau.

Action of heat in relation to materials used for insulation. J. L. Finck; United States Daily (Washington, D. C.), Vol. V, No. 76, p. 6; May 31, 1930.

Fire resistance tests of building materials and constructions. S. H. Ingberg; Proceedings, Eighteenth Annual Meeting, American Institute of Refrigeration (New York, N. Y.), p. 45; 1929.

Research at the Bureau of Standards on spontaneous heating and ignition. S. H. Ingberg; Report of conference on spontaneous heating and ignition of agricultural and industrial products, p. 21; 1930.

Safeguarding the storage of photographic, motion picture, and X-ray films. C. R. Brown; Journal, Radiological Society of North America (Chicago, Ill.), Vol. XIV, p. 454; May, 1930.

Effect of design on engine acceleration. D. B. Brooks and C. S. Bruce; Society of Automotive Engineers' Journal (New York, N. Y.), Vol. XXVI, No. 4, p. 471; April, 1930.

Semicommercial production of xylose. W. T. Schreiber, N. V. Geib, B. Wingfield, and S. F. Acree; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 22, p. 497; May, 1930.

The selective resistance of magnesium oxide. I. G. Priest and J. O. Riley; Journal, Optical Society of America (Ithaca, N. Y.), Vol. 20, p. 156; April, 1930.

Note on the yellowness of commercial magnesium carbonate and the alleged yellowness of magnesium oxide. I. G. Priest; Journal, Optical Society of America (Ithaca, N. Y.), Vol. 20, p. 157; April, 1930.

Note on the relative sensitiveness of direct color comparison and spectroscopic measurements in detecting slight differences in the spectral distribution of light. I. G. Priest; Journal, Optical Society of America (Ithaca, N. Y.), Vol. 20, p. 159; April, 1930.

Silencing the airplane. H. L. Dryden; preprint of paper presented at Fourth Aeronautic Meeting, American Society of Mechanical Engineers (New York, N. Y.), May 19–22, 1930.

Paper research literature, VII (Revised). C. J. West and B. W. Scribner; Paper Trade Journal (New York, N. Y.); May 22, 1930.

Knowledge of details vital in plans to build a pleasing home. John M. Gries and James S. Taylor; United States Daily (Washington, D. C.), Vol. V, No. 69, p. 6; May 22, 1930.

The National Bureau of Standards. George K. Burgess; Community Service Magazine (Community Service Co., Kansas City, Mo.); May, 1930.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75; other countries, $3.50. Subscription to Commercial Standards Monthly, $1; other countries, $1.25.

[2] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

U. S. GOVERNMENT PRINTING OFFICE: 1930